Improved Dynamic Modeling of the Cascade Distillation Subsystem and Integration with Models of Other Water Recovery Subsystems

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The Cascade Distillation Subsystem (CDS) is a rotary multistage distiller being developed to serve as the primary processor for wastewater recovery during long-duration space missions. The CDS could be integrated with a system similar to the International Space Station (ISS) Water Processor Assembly (WPA) to form a complete Water Recovery System (WRS) for future missions. Independent chemical process simulations with varying levels of detail have previously been developed using Aspen Custom Modeler (ACM) to aid in the analysis of the CDS and several WPA components. The existing CDS simulation could not model behavior during thermal startup and lacked detailed analysis of several key internal processes, including heat transfer between stages. The first part of this paper describes modifications to the ACM model of the CDS that improve its capabilities and the accuracy of its predictions. Notably, the modified version of the model can accurately predict behavior during thermal startup for both NaCl solution and pretreated urine feeds. The model is used to predict how changing operating parameters and design features of the CDS affects its performance, and conclusions from these predictions are discussed. The second part of this paper describes the integration of the modified CDS model and the existing WPA component models into a single WRS model. The integrated model is used to demonstrate the effects that changes to one component can have on the dynamic behavior of the system as a whole.